

WHAT IS CLAIMED IS:

1                   1.       A fault detection method comprising:  
2                   sensing a group of correlating operational parameters of a  
3 semiconductor processing tool operating under a recipe;  
4                   sensing at least one non-correlating operational parameter of the tool  
5 operating under the recipe;  
6                   forming an input vector including the group of correlating operational  
7 parameters and the at least one non-correlating operational parameter;  
8                   comparing the input vector to a reference data library comprising vectors  
9 from previous tool runs utilizing the recipe;  
10                  selecting from the reference data library one or more nearest neighbor  
11 vectors to the input vector based upon a similarity with the group of correlating  
12 operational parameters; and  
13                  generating a fault detection index from the selected nearest neighbor  
14 vectors.

1                   2.       The method of claim 1 wherein sensing the group of correlating  
2 operational parameters comprises sensing operational parameters relating to tool  
3 pressure.

1                   3.       The method of claim 1 wherein sensing the group of correlating  
2 operational parameters comprises sensing operational parameters relating to tool  
3 temperature.

1                   4.       The method of claim 1 wherein sensing the group of correlating  
2 operational parameters comprises sensing operational parameters relating to tool power.

1                   5.       The method of claim 1 wherein sensing the group of correlating  
2 operational parameters comprises sensing operational parameters relating to positioning  
3 of a wafer within the tool.

1                   6.       The method of claim 1 wherein the fault detection index is  
2 generated by compiling a vector subset from the selected nearest neighbor vectors,  
3 combining the vector subset into an output prediction vector, and generating a fault  
4 detection index from the output prediction vector.

1                   7.       The method of claim 6 wherein the output vector comprises  
2 predicted operational parameters, and the fault detection index is generated by  
3 combining the predicted operational parameters.

1                   8.       The method of claim 7 wherein combining the operational  
2 parameters of the output prediction vector comprises:  
3                   assigning a set of weights to the predicted operational parameters; and  
4                   adding together the weighted operational parameters.

1                   9.       The method of claim 8 wherein the set of weights is assigned  
2 based upon the similarity.

1                   10.      The method of claim 1 further comprising:  
2                   including in the input vector a value of a passive-inclusive sensor,  
3                   ignoring the value of the passive-inclusive sensor in selecting the nearest  
4 neighbor vectors; and  
5                   including the value of the passive-inclusive sensor in generating the fault  
6 detection index.

1                   11.      The method of claim 1 further comprising:  
2                   including in the input vector a value of a cluster sensor;  
3                   including the value of the cluster sensor in selecting the nearest neighbor  
4 vectors; and  
5                   ignoring the cluster sensor in generating the fault detection index.

1                   12.      The method of claim 11 wherein the cluster sensor represents a  
2 stage in a semiconductor fabrication process when the group of correlating operational  
3 parameters is sensed.

1                   13.      The method of claim 6 wherein the vectors of the reference data  
2 library include a synthetic sensor, the method further comprising:  
3                   including in the input vector a null value of the synthetic sensor; and  
4                   obtaining a predicted value of the synthetic sensor from the output  
5 prediction vector, the synthetic sensor ignored in selecting the nearest neighbor vectors  
6 and ignored in generating the fault detection index.

1                   14.     The method of claim 13 wherein the synthetic sensor is difficult  
2 or impossible to measure in real time during operation of the semiconductor fabrication  
3 tool, and is assigned to vectors of the library after completion of the processing.

1                   15.     An apparatus for detecting a fault in a semiconductor processing  
2 tool, the apparatus comprising:

3                   a first sensor, a second sensor, and a third sensor operatively coupled to  
4 the semiconductor processing tool;

5                   a controller in communication with the semiconductor processing tool  
6 and with the first, second, and third sensors;

7                   a memory coupled to the controller, the memory storing a computer  
8 program in computer readable format including computer instructions to control said  
9 controller to,

10                  receive from the first and second sensors correlating operational  
11 parameters of the semiconductor processing tool operating under a recipe,

12                  receive from the third sensor a non-correlating operational parameter  
13 from the tool;

14                  compare the correlating operational parameters to corresponding  
15 operational parameters recorded during prior runs of the tool utilizing the  
16 recipe, and

17                  generate a fault detection index from comparing the sensed correlating  
18 operational parameters to the corresponding operational parameters recorded  
19 during prior runs.

1                   16.     The apparatus of claim 15 wherein the correlating operational  
2 parameters relate to tool pressure.

1                   17.     The apparatus of claim 15 wherein the correlating operational  
2 parameters relate to tool temperature.

1                   18.     The apparatus of claim 15 wherein the correlating operational  
2 parameters relate to tool power.

1                   19.     The apparatus of claim 15 wherein the correlating operational  
2 parameters relate to positioning of a wafer within the tool.